MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2021/2022

DTM5016 – ANALOG AND DIGITAL COMMUNICATIONS

(Diploma in Electronics Engineering)

12 AUGUST 2022
3.00 – 5.00 P.M
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 4 pages excluding the cover page and appendix.
2. Answer **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers in the answer booklet provided.

QUESTION 1 [25 MARKS]

a) Given that the information signal $v_m = 5\sin(2\pi \times 6000t)V$ is transmitted.

i) Compute the wavelength of the given signal.
(Speed of light, $c = 3\times10^8 m/s$)

[2 marks]

ii) Would it be practical to directly transmit this information signal using an antenna? Why/why not?

[2 marks]

iii) Consider a carrier signal of $v_c = 10\sin(2\pi \times 240000\ t)V$ is amplitude-modulated by the information signal given above. If Double Side Band, Large Carrier (DSB-LC) is used, sketch and label the frequency spectrum of the baseband signal, the carrier signal and AM signal.

[5 marks]

iv) Compute the bandwidth of the AM signal.

[2 marks]

b) An AM superheterodyne receiver that uses high-side injection (HSI) with local oscillation frequency of $2500kHz$ receive an RF components of carrier, upper and lower side frequencies of $750kHz$, $800kHz$ and $700kHz$, respectively.
Determine the respective IF components:

(i) carrier frequency, f_c

(ii) upper side frequency, f_{USB}

(iii)lower side frequency

Hence, sketch the multi-tone frequency spectrum for the IF components.

[7 marks]

c) With the aid of the diagram, demonstrate the operation of FM stereo.

[7 marks]

Continued...

QUESTION 2 [25 MARKS]

a) Figure Q2 shows the input signal, *g(t)*. Sketch the sampled signal when the input signal is sampled with a 5kHz pulse train and have pulse width of $\tau = 50\mu s$ by using flat top sampling.

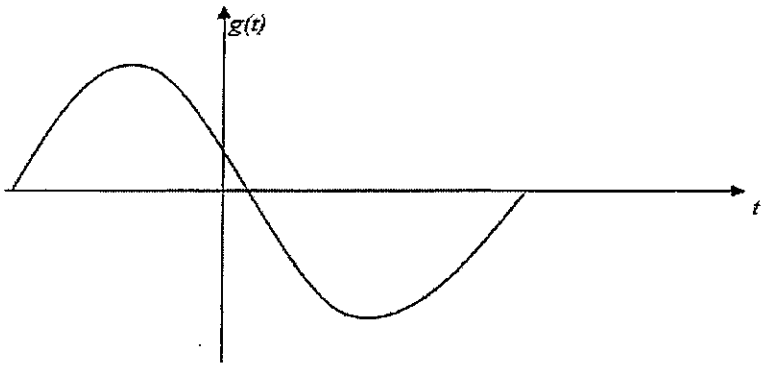

Figure Q2

[4 marks]

b) A compact disc (CD) records audio signals digitally by using PCM. Assume the audio signal bandwidth to be 15kHz. If the Nyquist samples are quantized into L=65536 levels and then binary coded, determine:

i) The Nyquist rate.

[2 marks]

ii) The bit required to encode a sample.

[3 marks]

iii) The number of binary digits per second (bps) requires to encode the audio signal.

[3 marks]

iv) The bandwidth, for a practical CDs that use 44100 samples per second.

[2 marks]

c) The human voice has a spectrum of frequencies ranging from 200Hz to 4000Hz.

i) Determine the quantization level and number of encoded bits, given that the required SNR to be at least 30dB.

[4 marks]

ii) Draw the block diagram of the PCM system. Demonstrate the function of each block.

[7 marks]

Continued...

QUESTION 3 [25 MARKS]

a) Sketch the modulated output for the data "0110101100" that have baud rate 5 baud/sec following modulation scheme.

(i) FSK

[2 marks]

(ii) 2-PSK

[3 marks]

b) Given a bandwidth of a transmission medium used is ranging from 2kHz to 10kHz. If the transmission using ASK full-duplex mode, compute the carrier frequencies in each direction. (Assume there is no gap between the bands in the two directions).

[5 marks]

c) Figure Q3 illustrates a constellation diagram that represent a modulated signal by a digital modulation scheme.

(i) Provide the modulation scheme used.

[1 mark]

(ii) For the system operating with an information bit rate of 24kbps, determine the baud rate.

[2 marks]

(iii)Provide **ONE** limitation of using this technique.

[2 marks]

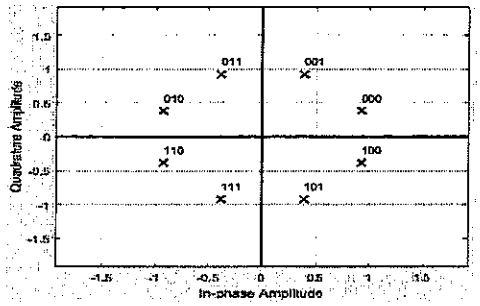

Figure Q3

d) Encode the bit stream 10000000000100 using the following encoding techniques.

(i) RZ

[2 marks]

(ii) Manchester

[2 marks]

(iii)B8ZS (Assume the polarity of the first 1 is positive)

[3 marks]

(iv)Which encoding technique that more suitable for long transmission. Why?

[3 marks]

Continued...

QUESTION 4 [25 MARKS]

a) Show the difference between single bit and burst bit error.

[6 marks]

b) If a spike of impulse noise lasts for 1ms, calculate the maximum number of characters that could be corrupted in a signal travelling at 12.7Mbps using an 8-bit code.

[2 marks]

c) If total bits transmitted is 12, determine the redundancy bit, r and the actual number of data bits, m.

[4 marks]

d) Refer to the ASCII code given in Table Q4.

(i) Calculate the checksum for character "ABSOLUTE".

[4 marks]

(ii) Verify the transmission is error-free.

[4 marks]

Table Q4

Character	ASCII Code
A	41
B	42
E	45
L	4C
O	4F
S	53
T	54
U	55

e) Consider the (7,3) cyclic code with generator $g(x) = x^4 + x^3 + x^2 + 1$. Construct the codeword for the message [1 0 1].

[5 marks]

End of Page

Appendix I: Table of Bessel Function

n \ β	0.05	0.1	0.2	0.3	0.5	0.7	1.0	2.0	3.0	5.0	7.0	8.0	10.0
0	0.999	0.998	0.990	0.978	0.938	0.881	0.765	0.224	-0.260	-0178	0.300	0.172	-0.246
1	0.025	0.050	0.100	0.148	0.242	0.329	0.440	0.577	0.339	-0.328	-0.005	0.235	0.043
2		0.001	0.005	0.011	0.031	0.059	0.115	0.353	0.486	0.047	-0.301	-0.113	0.255
3				0.001	0.003	0.007	0.020	0.129	0.309	0.365	-0.168	-0.291	0.058
4						0.001	0.002	0.034	0.132	0.391	0.158	-0.105	-0.220
5								0.007	0.043	0.261	0.348	0.186	-0.234
6								0.001	0.011	0.131	0.339	0.338	-0.014
7									0.003	0.053	0.234	0.321	0.217
8										0.018	0.128	0.223	0.318
9										0.006	0.059	0.126	0.292
10										0.001	0.024	0.061	0.208
11											0.008	0.026	0.123
12											0.003	0.010	0.063
13											0.001	0.003	0.029
14												0.001	0.012
15													0.005
16													0.002
17													0.001

Appendix II: Table of Trigonometric Identities

$$\sin A \sin B = \frac{1}{2}\left[\cos(A-B) - \cos(A+B)\right]$$

$$\cos A \cos B = \frac{1}{2}\left[\cos(A+B) + \cos(A-B)\right]$$

$$\sin(A+B) = \sin A \cos B + \cos A \sin B$$

$$\cos(A+B) = \cos A \cos B - \sin A \sin B$$

$$\sin\theta = \frac{1}{2j}\left[e^{j\theta} - e^{-j\theta}\right]$$

$$\cos\theta = \frac{1}{2}\left[e^{j\theta} + e^{-j\theta}\right]$$

Appendix III: Fourier Transform Pairs

$x(t)$	$X(f)$
$\delta(t)$	1
$\delta(t-t_o)$	$e^{-j2\pi ft_o}$
1	$\delta(f)$
$e^{j2\pi f_o t}$	$\delta(f-f_o)$
$e^{-at}u(t)$	$\frac{1}{a+j2\pi f}$, for $a>0$
$e^{at}u(-t)$	$\frac{1}{a-j2\pi f}$, for $a>0$
$e^{-a\lvert t\rvert}$	$\frac{2a}{a^2+(2\pi f)^2}$, for $a>0$
$rect\left(\frac{t}{T}\right)$	$T\text{sinc}(fT)$
$\text{sinc}(2Wt)$	$\frac{1}{2W}rect\left(\frac{f}{2W}\right)$
$\Delta\left(\frac{t}{T}\right)$	$\frac{T}{2}\text{sinc}^2\left(\frac{fT}{2}\right)$
$W\text{sinc}^2(Wt)$	$\Delta\left(\frac{f}{2W}\right)$
$e^{-\pi t^2}$	$e^{-\pi f^2}$
$\cos(2\pi f_o t)$	$\frac{1}{2}\delta(f-f_o)+\frac{1}{2}\delta(f+f_o)$
$\sin(2\pi f_o t)$	$\frac{1}{2j}[\delta(f-f_o)-\delta(f+f_o)]$

Appendix IV: Fourier Transform Properties

Let $x(t) \Leftrightarrow X(f)$, $x_1(t) \Leftrightarrow X_1(f)$ and $x_2(t) \Leftrightarrow X_2(f)$; and a, b, t_o and f_o scalar quantities.	
Linearity	$ax_1(t)+bx_2(t) \Leftrightarrow aX_1(f)+bX_2(f)$
Scaling ($a \neq 0$)	$x(at) \Leftrightarrow \frac{1}{\lvert a \rvert} X\left(\frac{f}{a}\right)$
Time Shifting	$x(t-t_o) \Leftrightarrow X(f)e^{-j2\pi f t_o}$
Frequency Shifting	$x(t)e^{j2\pi f_o t} \Leftrightarrow X(f-f_o)$
Time Convolution	$x_1(t) * x_2(t) \Leftrightarrow X_1(f)X_2(f)$
Frequency Convolution	$x_1(t)x_2(t) \Leftrightarrow X_1(f) * X_2(f)$
Time Differentiation	$\frac{d^n}{dt^n} x(t) \Leftrightarrow (j2\pi f)^n X(f)$
Frequency Differentiation	$(-jt)^n x(t) \Leftrightarrow \frac{d^n}{df^n} X(f)$
Time Integration	$\int_{-\infty}^{t} x(\tilde{t})d\tilde{t} \Leftrightarrow \frac{X(f)}{j2\pi f} + \frac{1}{2}X(0)\delta(f)$
Frequency Integration	$x(t)u(t) \Leftrightarrow \int_{-\infty}^{f} X(\tilde{f})d\tilde{f}$